APPENDIX A:
HYDRAULICS APPENDIX

UPPER YORK CREEK ECOSYSTEM RESTORATION PROJECT
FEASIBILITY STUDY
ST. HELENA, CA

Prepared by:

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1. Purpose

The purpose of the feasibility portion of the Planning, Design, and Analysis (PDA) phase is to determine the feasibility and costs of various alternatives and recommend a single alternative that will enable fish passage through and upstream of York Creek Dam. Presently, steelhead are unable to access habitat upstream of the dam because of direct blockage of the dam. The existing fish ladder is inoperable and does not tie in to the creek below and above the dam. Water presently flows down a standpipe behind the dam and exits through an outlet pipe at the base of the dam.

Primary objectives of this project are to improve fish passage in Upper York Creek, restore fluvial processes and decrease the risk of uncontrolled sediment releases at the dam, and to restore approximately two acres of habitat and connection between downstream and upstream of the dam. Secondary objectives of the project include the minimization of operations and maintenance activities and environmental impact, in addition to reducing erosion in the stream corridor.

This appendix presents the hydrologic and hydraulic information for three alternatives: complete removal of Upper York Creek Dam, partial dam removal, and construction of a new fish ladder through the existing dam.

2. Alternatives

The alternatives to be considered in this report include the following:

1. *Alternative 1, Complete Removal*– This alternative involves removing the dam, spillway, and all sediment behind the dam. The goal of this plan is to return the project area to a more natural state and enhance fish passage through the existing dam site. A new channel would be constructed through the existing dam site that has dimensions similar to a stable stream reach located upstream of the project site.

2. *Alternative 2A/2B, Notch Dam* – This alternative involves removing a portion of the dam while leaving the spillway in place (i.e., "cutting a notch" in the dam). The notch would be constructed such that earthen dam material is excavated along a slope of 1.5H to 1.0V (H = horizontal; V = vertical), which are considered to be stable slopes (USACE 2005). To the extent feasible, the same channel dimensions specified for the full dam removal alternative would be incorporated into this alternative as well. The creek would be aligned to accommodate the location of the notch in the immediate dam area.

3. *Alternative 3, Fish Ladder* – This alternative involves removing a portion of the dam, or possibly excavating a notch in the dam, and constructing a new fish ladder through the notch. The fish ladder would consist of a series of boxes 5 ft long and 4 ft wide. The boxes would be designed to accommodate a water depth of 12 inches so as to allow for a fish jump height of 12 inches or less.

3. Site Description

3.1. General

The project site is located on York Creek above the town of St. Helena, California, on the western side of Napa Valley. The headwaters of York Creek originate at an elevation of approximately 2200 feet. The creek flows in an easterly direction through a narrow canyon before joining the Napa River northeast of St. Helena at an elevation of approximately 225 feet (DWR 2002). The creek parallels Spring Mountain Road, which is a two lane highway that connects St. Helena to Santa Rosa. Plate 1 shows the York Creek project site and surrounding area.

The Upper York Creek watershed originates on the western side of the Napa Valley watershed at an elevation of approximately 2200 feet. The creek flows in an easterly direction through a narrow canyon before joining the Napa River northeast of St. Helena at an elevation of approximately 225 feet (DWR 2002).

For this study, the watershed was divided into three areas. The area encompassing the ridge tops of the watershed to the top of the dam is 2.48 square miles. The area below the dam to the diversion structure is .35 square miles. The area below the diversion structure to the confluence of York Creek with the Napa River is 2.18 square miles.

3.2. Upper York Creek Dam and Reservoir

Upper York Creek Dam is approximately 50 feet high and has an existing capacity of 20 acre-feet. The base of the dam is at an elevation of 570 feet, and its crest is at an elevation of 620 feet. According to the California Department of Water Resources (DWR), the depth of sediment accumulation behind the dam is approximately 25 feet and extends 600 feet upstream (2002).

The reservoir, referred to as the Upper Reservoir, has both a concrete spillway that follows Spring Mountain Road adjacent to the project site and a drain pipe spillway behind the dam crest. The concrete spillway is approximately 255 feet long and varies in width along its length. The drain pipe spillway consists of a 6-foot diameter steel riser pipe with a trash rack on top. It extends down 26 feet and connects with a stone masonry tunnel at elevation 577.6 feet. The stone masonry tunnel is 175 feet long, 3 feet in diameter, and has an outlet at the base of the dam at elevation 570.8 feet (DWR 2002).

River stationing, profiles, and cross sections are shown in Plates 5 through 16. At the lower portion of the project site to the bottom of the dam, station 0+000 to 0+280, the creek has a 5% slope. The dam face has a steep slope of approximately 69%. From just behind the dam to upper-most extents of the project site, station 0+500 to 1+325, the creek has a 1.25% slope.

4. Prior Studies and Reports

Previous hydrology and hydraulic design efforts related to this project on Upper York Creek are presented in the following publications.

a) *York Creek Dam Removal – Hydraulic Analysis*. July 2, 2002. Erika Kegel. California Department of Water Resources, Division of Planning and Local Assistance, Resource Restoration and Support Branch, Fish Passage Improvement Program, Sacramento, CA.

b) *York Creek Sediment Transport Analysis*. April 2002. Erika Kegel. California Department of Water Resources, Division of Planning and Local Assistance, Resource Restoration and Support Branch, Fish Passage Improvement Program, Sacramento, CA.

c) *Sediment Sampling and Analysis of York Creek Dam and Upper Reservoir Site Integrated Storage Investigation (ISI)*. August 2001. California Department of Water Resources, Division of Planning and Local Assistance, Site Assessment Unit, Sacramento, CA.

d) *York Creek Dam Removal – Slope Stability Analysis*. June 5, 2002. Author Unknown.

e) *Initial Study for the York Creek Diversion Modification Project, Napa County, California*. November 2002. California Department of Water Resources, Division of Planning and Local Assistance, Resource Restoration and Support Branch, Fish Passage Improvement Program, Sacramento, CA.

f) *York Creek Physical Baseline Assessment Report*. November 27, 2002. Entrix, Inc., 7919 Folsom Blvd., Suite 100, Sacramento, CA 95826.

g) *Revegetation and Monitoring Plan for the York Creek Dam Removal and Stream Restoration Project*. March 2002. California Department of Water Resources, Environmental Services Office, Sacramento, CA.

h) *Initial Study/Proposed Mitigated Negative Declaration for the York Creek Dam Removal and Stream Restoration Project*, Napa County, California. July 2002. The City of St. Helena, CA.

i) *York Creek TR-55 Calculated Peak Discharges*. January 17, 2002. Chip Bouril, USDA. Email to the USACE Water Resources Section.

j) *Final Report, HTW Assessment, Upper York Creek Ecosystem Restoration Project, St. Helena, California*. December 2003. Innovative Technical Solutions, Inc., 2730 Shadelands Drive, Suite 100, Walnut Creek, CA 94598.

k) *Upper York Creek Dam Removal Project, Section 206: Aquatic Ecosystem Restoration, Basin Hydrology Assessment*. March 2005. Water Resources Section. San Francisco District Army Corps of Engineers, 333 Market Street, San Francisco, CA 94105.

4.1. Available Data

There is no stream gage data for the creek, and there are no design drawings for the dam. A topographical survey of the dam and the surrounding area was done in 2001 and 2002 by Albion Surveys. This survey was used as input to various models throughout the course of this study.

A short surveying effort was done by the San Francisco District in February 2005 in order to obtain cross section data for a natural channel design. The cross sections are characteristic of a more natural creek environment without the effects of sediment accumulation from behind the dam. This data also provides information on pool and riffle characteristics. These cross sections presently overlap a portion of the Albion Survey. They have been included in on sheets 3-9 and 3-10 of the Civil Design Appendix. These cross sections are upstream of the dam and beyond the reach of sediment buildup behind the dam.

5. Hydrology and Discharge Frequency Curve

A basin hydrology assessment was completed with the use of the Army Corps computer program HEC-HMS (Hydrologic Engineering Center's Hydrologic Modeling System). The program was used to simulate the precipitation-runoff process for the York Creek watershed. Peak flow rates were obtained and then compared to data from a DWR TR-55 modeling effort (Technical Release 55). Peak flow rates are listed in Table 1. The design discharges used in this project are listed on the first row. More information on the basin hydrology assessment for this project site may be found in reference *K* listed in Section 4.

Table 1. York Creek Peak Discharge Rates At Dam

Design Discharges for Project (cfs)

(Drainage area is 2.48 mi^2.)

Return Period (yrs)	**2**	**10**	**25**	**50**	**100**
Design Discharges (cfs)	116	423	707	960	1281

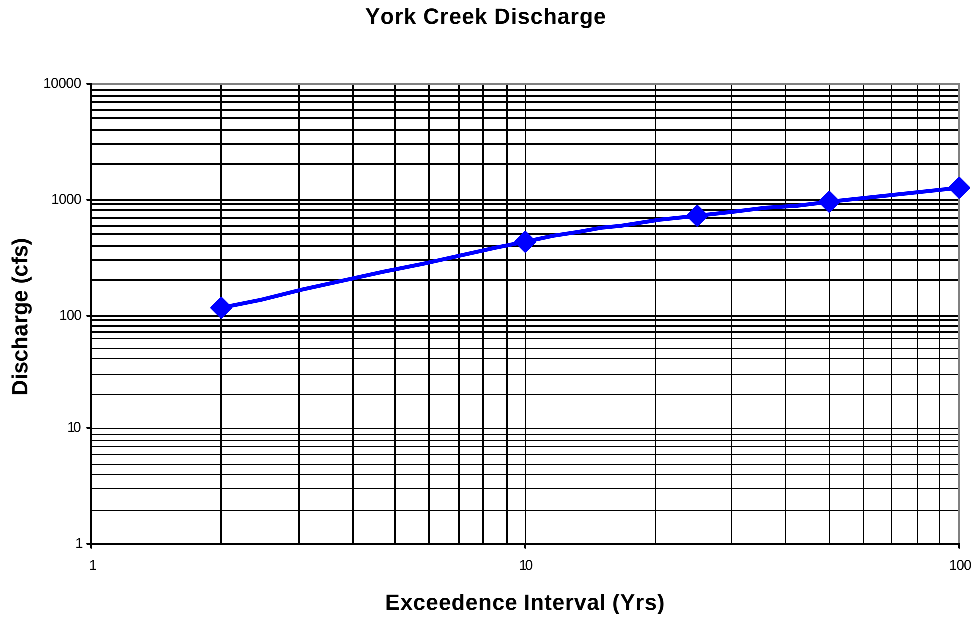

Figure 1. Flow discharge curve for York Creek.

6. Existing Conditions

6.1. Streamflow and Velocities

The existing conditions were modeled using the Hydrologic Engineering Research Center's River Analysis System (HEC-RAS). Input to the model was the 2001 Albion survey, which shows the existing site topography. The Albion survey shows the topography of the dam, the reservoir behind the dam, and downstream of the dam. The survey does not extend all the way down to the confluence of York Creek with the Napa River. No data is available for the creek where it flows through the flatter portions of the city of St. Helena towards the Napa River (i.e., from Berringer Vineyards) .

River stationing has been established within the project site to aid in comparing existing conditions and with project conditions. River stationing is shown in on Sheets 4 - 7 of the Civil Design Appendix. From 1+325 to 1+025, a Mannings n of 0.04 was used for the channel (Chow 1959). From 1+000 to 0+450, a Mannings n of 0.035 was used. A Manning's n of 0.06 was used for both stream over banks in the model. Input flows used were those calculated from the basin hydrology study (2-Yr, 10-Yr, etc; see section 5). Reach boundary conditions were assumed to be critical depth. The flow regime was assumed to be mixed flow.

For the one hundred year flow rate of 1281 cfs, velocities of the creek upstream of the dam are less than or just over 1 ft/sec from 0+450 to 0+700. From 0+700 to 0+900, velocities gradually increase from 2 to 5 ft/sec. Stations 0+950 and 0+975 show higher velocities of 14.5 ft/sec. Upstream of station 0+975, velocities are generally between 5 and 10 ft/sec. Upstream of station 1+175, velocities range from 12 to 14 ft/sec. Velocities are higher below the dam, about 13.5 to 14 ft/sec.

The velocity data produced by the HEC-RAS program show that creek velocities are high where the topography is steep in the upper reaches of the project site and low in the reservoir area behind the dam. These results compare favorably with the DWR modeling effort. DWR's HEC-RAS results also show velocities dropping to 1 cfs or less behind the dam before draining into the riser pipe. Velocities rise to approximately 12 fps at the convergence of the flow from the riser pipe and the spillway and than slow to 8 fps at the extent of their modeled project site (DWR 2003). (DWR's 100-year flow rate for model input was 1424 cfs.) DWR incorporated details about the riser pipe, spillway, and dam into their model, whereas the Army Corps model did not. As such, there is some uncertainty associated with the velocity values for the cross sections below the dam. It assumed that the DWR model and accompanying results are sufficient for comparing and describing the expected velocities for existing conditions.

6.2. Sediment

As mentioned previously in section 3.1, the reservoir behind the dam has filled in with sediment so that it has essentially no capacity. The estimated amount of sediment material behind the dam is 26,042 yds^3. Approximately 10,000 yd^3 of sediment was removed from behind the dam in 1992-93 (Goldman). As a very rough estimation, approximately 16,000 yds^3 may have been transported by York Creek and deposited behind the dam in a 12 year time period, or 1,333 yds^3 a year.

6.3. Sediment Transport Capacity – Existing Conditions

In order to determine areas of deposition and erosion in the existing site, the hydraulic criteria used as input to the Army Corps RAS model for determination of velocities was also used as input to the RAS sediment transport capacity function. The gradation curve used as input to the model was that which was generated by DWR in 2001-2. It has been reproduced below in Figure 2. The specific gradation used in the computation is the data plotted with the black line, which corresponds to DWR reservoir sediment sample number 3. D_{50} for this sample is .93 mm. The Meyer-Peter Muller (MPM) function was used and produced the most appropriate results for York Creek. The MPM function is based on experimental data and has been tested and used for rivers with relatively coarse sediment. The range of overall particle diameters for this function is from 0.4 to 29 mm. The range of velocities is from 1.2-9.4 fps (HEC 2002).

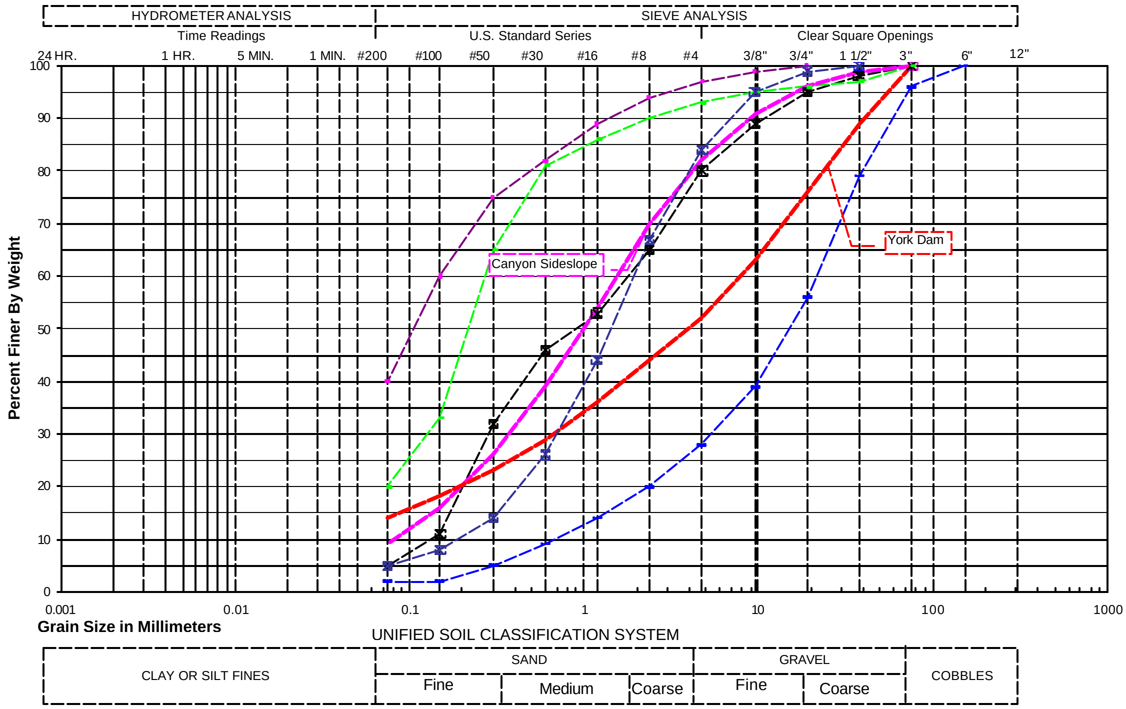

Figure 2. DWR Gradation Curve.

From station 0+425 to 0+700, the reservoir area, York Creek has essentially no sediment transport capacity. Portions of the creek between stations 0+925 and 1+000 and from 1+150 to 1+125 show slightly larger transport capacities. These results indicate that the area behind the dam is depositional in nature. Some portions of the creek upstream from the dam have a greater ability to pass sediment than those nearer to the dam.

If the dam is not removed, most of the sediment carried by York Creek would probably continue to accumulate around the riser pipe in the reservoir area, much as it has done in the past. Uncontrolled releases of sediment in large quantities could be possible from either maintenance of the riser pipe or from erosion of the dam itself by water that has overtopped the dam during a significant hydrologic event. Exact quantities of sediment to be released under either of these scenarios is unknown. Previous records indicate that a sudden release in sediment has resulted in fish kills, but the exact origin of the sediment release isn't clear.

Since there are no significant land activities planned for the next fifty years within the existing watershed, we don't expect to see an appreciable change in the historical quantity of sediment that York Creek has passed. In other words, we don't expect to see different sources of sediment other than what has traditionally contributed to the sediment transported by the creek. Possible contributors to sediment transported by the creek include but are not limited to the streambed, stream bank material, an unauthorized dump of sediment into the creek, a release of debris and/or sediment from cleaning the riser pipe, mass wasting from a landslide adjacent to the area, agricultural activities or possibly sediment from the dam itself.

7. Hydrology for Fish Passage and Fish Ladder Alternative

Although flow rates for York Creek were determined for certain return periods in the basin hydrology assessment, flow rates were also quantified per month to aid in the design of fish passage features in the full and notch alternatives and for the fish ladder design. Quantification of hydrology for fish passage and ladder design typically involves the computation of flow duration exceedence curves at the proposed site for fish passage for the months during which fish migrations occur (Thrall and Banys 1993, NMFS 2004). The curves should be based on the entire period of record of mean daily streamflow data, or at least the last 25 years of mean daily streamflow discharges (NMFS 2004). Since York Creek has no stream gage data, flow duration curves were generated by "transferring" mean daily streamflow data from nearby, similar watersheds to the York Creek watershed in accordance with the method outlined in ERDC/CHL TR-01-28 (i.e., regionalized duration curve method). Mean daily streamflow data used to create the curves consisted of all available data from the following U.S. Geological Survey (USGS) gages: Nevada Creek near Knoxville, Adams Creek, Sulphur Creek, Dry Creek near Napa, and Santa Rosa Creek near Santa Rosa. The location of these creeks in relation to York Creek is shown in Plate 2. A set of exceedence data was computed for each of the five creeks, which was then averaged together to create one set of curves for York Creek. The flow duration curve data is shown in Figure 3. Figure 3 indicates that that the flow is essentially non-existent during the summer for York Creek.

7.1. High Fish Passage Mean Daily Design Flow

High fish passage design flow is the mean daily average stream discharge that is exceeded 5% of the time during periods when migrating fish are normally (historically) present at the site. This is the highest stream discharge for which migrants are expected to be present, migrating, and dependent on the proposed facility or fish passage structure for safe passage (NMFS 2004).

7.2. Low Fish Passage Mean Daily Design Flow

Low fish passage design flow is the mean daily average stream discharge that is exceeded 95% of the time during periods when migrating fish are normally (historically) present at the site (NMFS 2004).

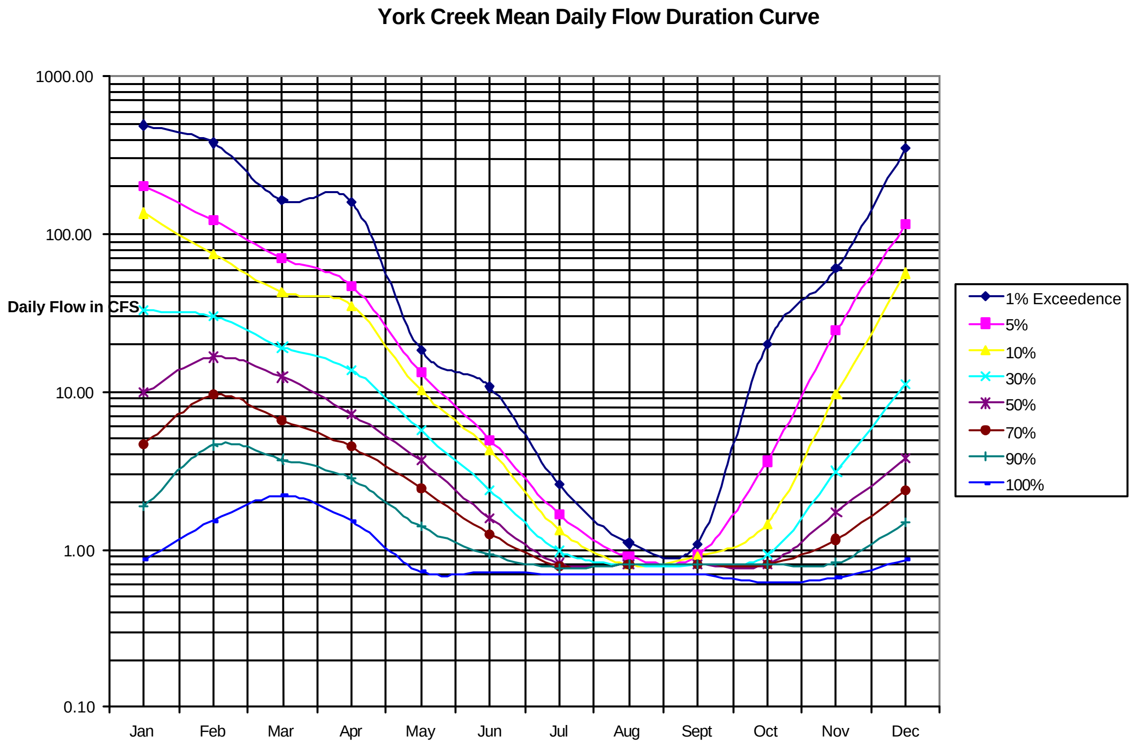

Figure 3. Mean daily flow duration curves for York Creek for each month.

8. Geomorphology

In this section restored channel dimensions and parameters will be described in the following paragraphs. Two restoration alternatives will be developed from these dimensions and parameters.

Creek Design One. This alternative will be designed to include all features of a functioning creek. The design will include channel cross-sections, plan form, pools and riffles, channel slope and bottom material. See plates 3 -6 of this report and Sheets 2, 3-1 through 3-10, 4, 5, 6 and 7 of the Civil Design Appendix.

Creek Design Two (recommended). This restoration alternative would be limited to a basic cross-section, plan, slope and bottom material. The basic cross-section will be similar to the riffle detail on Plate 7 of this appendix. Pool and riffles would be allowed to form naturally over time within this cross-section.

At the end of this section Table 7 will present a summary of the two creek designs.

A geomorphic assessment of York Creek was completed by Entrix, Inc., in November 2002. This report is available through the city of St. Helena. The data from this report was used in the design of pools, riffles, and runs for the alternatives.

8.1. Condition of York Creek Upstream and Downstream from the Upper York Creek Dam Site

York Creek is in reasonably good condition from a geomorphic perspective upstream and downstream from the dam site. Pools, riffles, meanders and gravel bars are typical of streams that have been subject to limited human impacts. Gravel has been trapped by the existing dam and has reduced the volume of smaller sized gravel to a not quantified extent. Past history of sediment removal from the site and recent history indicate that gravel supply for any restoration project is adequate.

8.2. Channel Cross-Sections

A representative stream reach that was not impacted by the sediment accumulation behind the dam was used to develop cross sections for a new excavated channel for the alternatives. Based on the representative stream reach, the suggested cross section for the new channel should be approximately 23 feet wide, 5 feet deep, and have a bench that measures 2-50 feet depending on location within the project site. Due to the fact that the project varies in width, a full 50-foot wide bench may not be possible throughout the entire project site.

Cross section data from the representative stream reach is shown in Sheets 3-9 and 3-10 of the Civil Design Appendix. The location of the reach is shown in Sheet 2 of the Civil Design Appendix.

8.3. Channel Plan and Sinuosity from Representative Reach

In order to determine the new planform for the stream channel, an approximate meander wavelength from the representative reach area was used. The representative reach used is immediately upstream of the proposed restoration area and has a similar slope. The exact amplitude of the wavelength could not be fully accommodated within the project site due to the narrowness of the site in certain areas. Therefore a meander plan was developed that will fit into the restoration area.

8.4. Low Flow Channel Features

8.4.1. Pools and riffles

Pools, runs, and riffles were incorporated into the cross section, profile and planform designs based on data from the Entrix report (See Table 2 below).

Table 2 . Pool, riffle, and run characteristics from Entrix report.	
Pool Length (ft)	105
Pool Depth (ft)	~ 1.5
Riffle Length (ft)	128
Riffle Depth (ft)	~ 0.3
Run Length (ft)	275

For York Creek, the approximate location and characteristics of these features are listed in Tables 4, 5, and 6.

Table 3. Proposed Pools and Locations

Pool	Station
1	4+74 to 5+79
2	7+34 to 8+39
3	9+94 to 10+99
4	11+63 to 12+68

Table 4. Proposed Riffles and Location

Riffle	Station	Approximate Length (ft)
1	4+10 to 4+74	64
2	6+70 to 7+34	64
3	9+30 to 9+94	64
4	10+99 to 11+63	64
5	13+36 to 14+00	64

Table 5. Proposed Runs and Location

Run	Station	Approximate Length (ft)
1	5+79 to 6+70	92
2	8+39 to 9+30	92
3	12+68 to 13+36	69

8.4.2. Invert elevations

Invert elevations for the stream channel are listed in Table 7.

Table 6. Invert elevations.	
Station	**Invert Elevation (ft)**
0+000	556
0+100	561
0+200	566
0+300	572
0+400	576
0+500	579
0+600	587
0+700	594
0+800	595
0+900	602
1+000	607
1+100	612
1+200	613
1+300	618
1+400	620

8.5. Channel Slope

The channel slope from just behind the dam to the furthest upstream extent of the project site is approximately 1.25%. For the full dam removal and notch alternatives, the channel slope will be approximately 5%. For the fish ladder alternative the channel slope in the project area is approximately 3%.

8.6. Channel Bottom Material

The existing channel bottom material in the representative stream reach consists mostly of boulders and cobbles for the entire width of the stream. The existing material was classified by Entrix and is shown in Figure 4. It is suggested that the excavated stream channel be lined throughout its entirety with cobbles and boulders of similar gradation to that which is found in the representative stream reach (Figure 4).

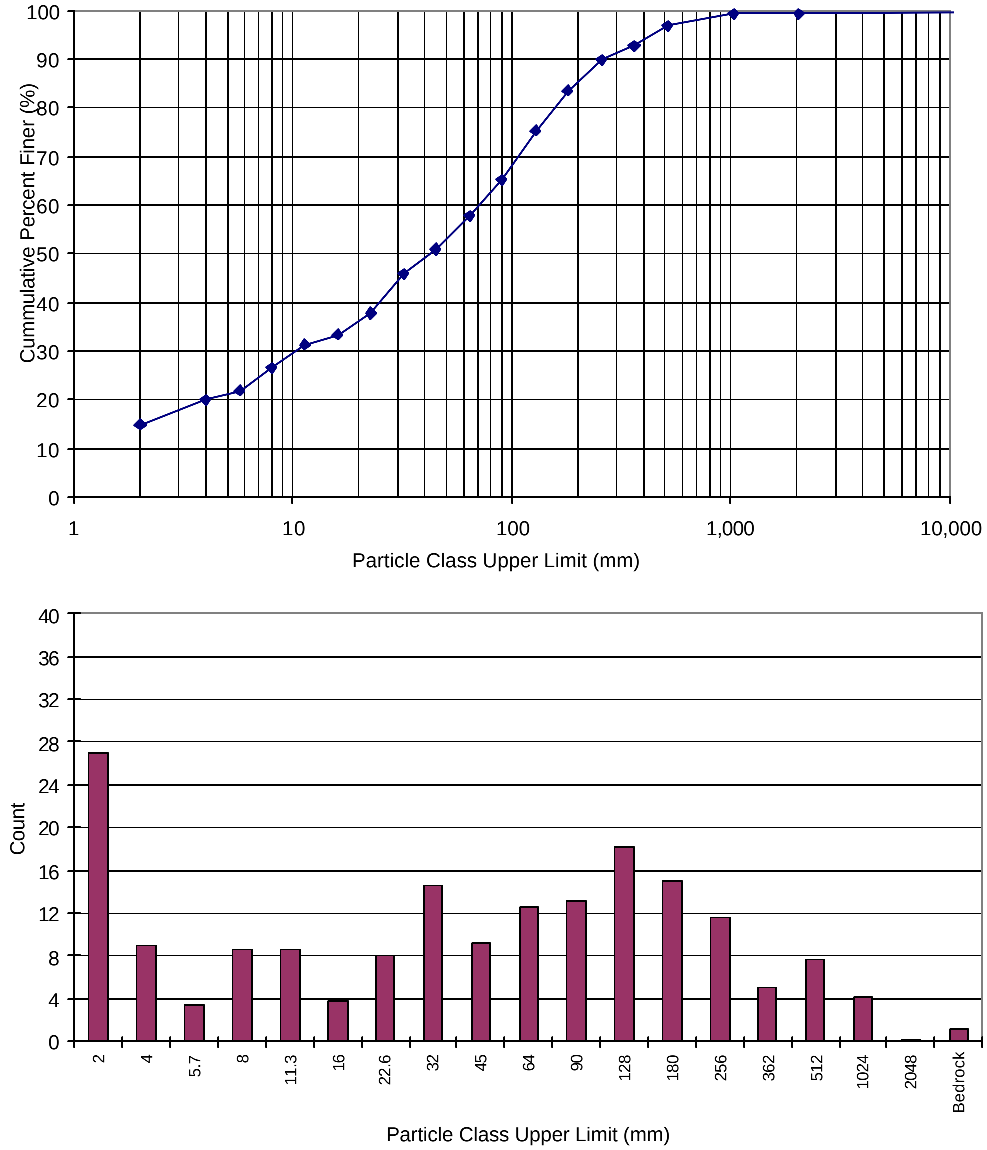

Figure 4. Entrix Geomorphic Assessment: Particle Size Distribution.

Table 7 Creek Restoration Features and Comments		
Design	Features	Comments
1	channel cross-sections, plan form, pools and riffles, channel slope and bottom material	An attempt to restore the channel to its pre-dam configuration.
2	channel cross-section, plan form, channel slope and bottom material	Provides a simple cross-section*, plan and original slope. Pools, riffles and bars will form over time. Recommended design.

* Similar to the riffle detail on Plate 7.

8.7. Additional Comments

Restoration of York Creek to its pre-dam condition should be relatively simple when compared to other creek restoration projects. There are no flood control issues, a full right of way is available, the creek upstream and downstream from the project area is in reasonable condition. The restored project area should easily tie into the existing creek slope upstream and downstream from the restoration area. There is an adequate supply of gravel to the restoration area. A simple cross-section set on the original channel invert elevation combined with a reasonable meander plan should provide a good base for future channel evolution.

9. Alternative 1A, Complete Removal

In the full dam removal alternative, the dam, spillway, and all of the sediment behind the dam are removed. The plan view is shown in Plate 3 of this appendix and Sheet 4 of the Civil Design Appendix. The profile of the new channel is 5%, as shown in Plate 7 of this appendix and Sheet 2 of the Civil Design appendix. Plate 7 of this appendix also shows example cross sections for the site. Additional project cross-sections are shown on Sheets 3-1 through 3-10 of the Civil Design Appendix. The proposed channel cross section has a bottom width of approximately 23 ft and is 5 ft deep. It also has a bench that varies from 2 to 50 ft depending on location in the project site. Larger benches are possible from 0+425 to 0+700, at which point they start to decrease in width due to the narrowness of the project site.

Water velocity is expected to increase in the project area with implementation of this alternative (the proposed project will not change existing channel velocities upstream or downstream from the project area). Using the HEC-RAS program, the velocities listed in Table 7 are expected. The highest velocity expected in with-project conditions is approximately 13 fps, which corresponds to a one hundred year event.

For the RAS modeling effort, a Mannings n value of 0.045 was used for the streambanks. A value of 0.05 was used for the channel. Reach boundary conditions were assumed to be critical depth. The flow regime was assumed to be mixed flow.

Table 8 **Approximate velocities (fps) for full dam removal.**		
Return Period (yr)	Flow (cfs)	Vel (ft/sec)
2	116	5.75
10	423	9
25	707	11
50	960	12
100	1281	13

Unlike the existing conditions, a fairly constant velocity is evident in the project site from stations 1+075 downstream. The velocity does decrease in the areas of 1+325 to 1+250 and 1+200 to 1+125. These areas are presently depositional in nature.

The flow duration data was also entered in the RAS model to look at expected flows during fish passage. Approximate velocities are listed in Table 8.

Table 9

York Creek Alternative 1, Complete Removal Mean Daily Flows (cfs), Associated Velocities (fps), and Water Depth (ft) for 5 and 95% Exceedence

Month	Discharge (cfs)		Velocities (fps)		Water Depth (ft)	
	5%	95%	5%	95%	5%	95%
Dec.	115.14	1.17	5.30	0.98	0.94	0.08
Jan.	202.70	1.35	6.25	1.00	1.29	0.09
Feb.	122.49	3.05	5.35	1.41	0.97	0.13
Mar.	69.98	2.96	4.50	1.35	0.71	0.13
Apr.	47.12	2.15	3.95	1.22	0.57	0.11
May	13.15	1.06	2.50	0.92	0.28	0.08

The velocities listed in Table 8 indicate that velocities are higher in the winter months when there is more rain in the region. Adult steelhead would most likely be able to migrate upstream given these velocities from December to May, although velocities over 10 ft/sec begin to hinder swimming ability in adults (Pauley et al 1986, McEwan et al 1996). The velocities associated with the high design flows may actually preclude upstream passage of juveniles in winter months. It's assumed that York Creek will be essentially dry, or have as little as 1 cfs of flow, in the summer months. The velocity of 13 ft/sec associated with the one hundred year return period event would most likely prove too fast for juveniles and may start to encumber upstream migration of adult steelhead.

For Alternative 1, the sediment transport capacity of RAS was used to assess aggradation and degradation in the project site. Unlike the existing site condition where the dam acts as a sediment trap, Alternative 1 has greater capacity in the creek cross sections and transports sediment though the restoration area at near equalibrium. Possible deposition areas are from 1+300 to 1+225 and from 1+200 to 1+175. It is assumed that these areas may fill in over time and eventually match the 5% profile in the rest of the project area (the slopes in these areas are less than 1%). Another possible deposition area for sediment is where the slope of York Creek decreases as it begins to traverse the valley towards its confluence with the Napa River (near Berringer Vineyard). Creek capacities in this area may be reduced over time as sediment falls out in these flatter areas. Sediment deposition on alluvial fans (valley bottoms) is a natural process and is to be expected in this area.

10. Alternative 2A/2B, Notch Dam

The partial dam removal alternative will have the same profile and planform as the full dam removal alternative. Instead of removing the entire dam and spillway, the spillway will be filled with sediment and a cut slope of 1.5H:1V will be made to form the notch from the right side of the spillway (looking downstream). This alternative differs from the full dam removal alternative in that there will be no bench from 0+425 downstream through the existing dam material. There will be adequate distance between the new slope cut into the dam and the opposite canyon slope for the proposed channel cross-section. Plan and profile views of Alternatives 2A and 2B are presented on Plates 4, 5 and 7 of this appendix and on Sheets 2, 5 and 6 of the Civil Design Appendix. Alternative cross-sections are shown on Sheets 3-1 through 3-10 of the Civil Design Appendix.

The toe of the proposed cut into the Upper York Creek dam will need protection from erosion. In the paragraph below and in Table 10 riprap sizing and placement requirements are discussed.

Table 10 provides approximate water surface elevations for the 100-year flow rate through the notch. It is suggested that an additional 3 feet of freeboard be used if toe of slope protection such as riprap is incorporated into the design and built to withstand the 100-year flow velocities. The top of the riprap slope will be approximately 4.5 feet above the channel invert and will extend 5 feet below the proposed channel invert. See riprap details on Sheet 11 of the Civil Design Appendix. Using equation 3-3 from EM 1110-2-1601, an approximate D_{30} size for riprap is 2 ft. The velocity value of 13 fps was used as input to the equation. Additional riprap and grade control discussion is in Section 12.

Table 10 Approximate water surface elevations at stations through notch.		
Station	Water Surface Elevation (ft)	Water Surface Elevation, with additional 3 ft (ft)
0+325	576	579
0+350	577	580
0+375	579	582
0+400	580	583
0+425	581	584
0+450	582	585

The expected velocities and areas of possible deposition for this alternative are the same as those for the full dam removal.

11. Alternative 3, Fish Ladder

This alternative was developed as a method to reduce the extent of dam removal. Alternatives 1, 2A and 2B require partial or complete of the dam to the elevation of the original streambed. Under this alternative dam removal would be less extensive. A section of the dam would be lowered approximately 20 feet. A fish ladder would then be constructed on the remaining face of the dam and would tie in to the creek upstream of the dam site. The advantage of this alternative is that it reduces the volume of material to be removed and there is less concern of dam slope stability. The main disadvantage of this alternative is that fish ladders for this application are less reliable for fish passage and require more maintenance than a creek at its natural stream bed elevation.

The suggested fish ladder for this project site is a step-pool/weir design through the existing dam site. This type of ladder was chosen after reviewing all types and different configurations of fish ladder designs presented in several publications produced by various state agencies. This ladder would be made entirely of concrete so as to avoid sediment contributions from the sides of the dam. The only source of sediment is expected to come from upstream sources. A Denil-type ladder was not considered due to the high slope on which it would have to be constructed and the possible cost associated with such a structure. The dimensions for the ladder are as follows.

The width of each step in the fish ladder structure is 23 ft, which is also the width of the upstream portion of the creek. The actual width of the box in each step is 4 ft. It is 5 ft long and 20 inches high. The corners in the back of the box should be rounded so that a dead zone of inactivity is not established in each pool. The opening of the box is 1.5 ft wide and has a notch that extends down18 inches. The expected jump height between each box, with water, is 12 inches or less. See sheet 10 of the Civil Design Appendix.

The fish ladder would be built from 0+275 to 0+435. The structure would be built into a 23% slope through the site. The structure will pass all flows and should accommodate passage of all lifestages of fish. From October to late April, the creek is expected to be concentrated to flowing into the boxes (it would pass through a weir into the first box at the top of the structure). In summer, the ladder would be essentially dry. Unlike a largescale hydroelectric dam that always has a functioning reservoir behind it, a consistent flow rate, a consistent velocity, and attraction flows cannot be guaranteed or implemented at this site. Flow rates are expected to change into and through the ladder depending on the time of year and thus the flow rate of York Creek.

The upstream and downstream portions of the creek from the fish ladder will have the same dimensions and design features as the full dam removal and notch alternatives. The profile upstream of the fish ladder will be 3% instead of 5%. As such, velocities approaching the ladder are expected to be slightly reduced due to the more gradual slope. Routine maintenance for this structure will be required to ensure fish passage. Plan and profile views of this alternative are presented on Plates 6 and 7 of this appendix and on Sheets 2, 7 and 10 of the Civil Design Appendix. Alternative cross-sections are shown on Sheets 3-1 through 3-10 of the Civil Design Appendix.

12. Riprap and Grade Control

Riprap requirements

Alternative 2A/2B includes a partial removal of the Upper York Creek Dam (also called the Notched Dam Alternative). The remaining dam embankment will be stabilized so that it will continue to support Spring Mountain Road. As part of maintaining slope stability the lower slope of the dam will be protected against erosion with vegetated riprap. Vegetation alone will not protect the embankment against calculated channel velocities of 13 ft/sec. If the toe is allowed to erode the geotechnical design safety factors will change and the road above could be subject to sliding.

Riprap sizing was determined using the following method:

1. The Corps HEC-RAS hydraulic computer model was used to model the proposed restoration design. Channel velocities calculated for this model were in the 12 to 13 ft/sec range.
2. Riprap sizing was calculated by using equation 3-3 of EM 1110-2-1601 1 July 1991. The resulting rock size is a D_{100} of 42 inches.

Existing sediment that is moving through the project area is in the 12 to 20 inch range. A lesser number of large boulders 30 inches across and greater are in the project areas. These observations indicate that the selected riprap size (42 inches) is reasonable.

The height of the riprap above the proposed design channel bottom was determined by first calculating the 100-year water surface elevation with a selected design n value (n =

.05). Since there is uncertainty in the initial design water surface elevation the 100-year water surface was re-calculated with an estimated high n value (n = .0625). The high n value water surface will set the extent of the riprap slope protection on the remaining bank embankment. The design riprap elevation will be set 4.5 feet above the proposed channel invert.

Additional riprap will be required at the toe of the riprap slope to support the slope and to protect against scour. A toe trench as shown in Figure 1 will be constructed 3 feet below the planned channel bottom.

The riprap will be placed with soil and willow stakes. A willow mattress will also be placed at the toe of the riprap slope. The riprap will be placed on a 1V:1.5H slope.

The filter behind the riprap will be constructed of geotechnical fabric reinforced with geogrid matting. The filter layer can also be constructed of rock and gravel if appropriate for vegetation, geotechnical stability and economical.

Grade Control

Current design alternatives have not included plans for significant grade control. However grade control may be necessary for the following reason. During construction of the dam the York Creek's natural gravel streambed may have been removed to prevent seepage under the dam. Also there may have been disturbance to the creek upstream of the dam during construction. Current alternative designs have assumed that the original channel bed material wood still be in place and be available for the restored design. This may not be true therefore channel restoration may require grade control for the final restored channel bed. Grade control should be planned for however the required extent and locations will not be known until construction is under way and the proposed projects creek bed is exposed.

13. Summary

From a geomorphology stand point York Creek is in reasonably good condition upstream and downstream from the Upper York Creek Dam. Restoration of the creek through the dam site can be done with a simple design that emphasizes a basic cross-section, channel invert elevations and a plan layout. Gravel deposition will form pools and riffles over time.

Alternatives 1, 2A and 2B most closely restore the streambed and channel cross-section to its pre-dam condition.

Alternative 3 will require less dam and sediment removal. However the Alternative 3 fish ladder will require more maintenance and will be less reliable for fish passage than Alternatives 1, 2A and 2B.

For alternatives 2A and 2B what remains of the dam will require protection against erosion.

The restored creek bed may require grade control.

The estimated annual bed load deposited behind the existing dam site is 1,333 cubic yards. This estimate is based on maintenance records and recent surveys.

The removal of the Upper York Creek dam will allow sediment that is now trapped behind the dam to move downstream to the Napa River. Some of this additional sediment may be deposited in the the York Creek channel bottom as it flows though the Napa Valley floodplain. The Corps is aware that additional sediment on the channel bottom will decrease channel capacity. The reduction in channel capacity, increases in flood duration and depth is currently estimated to be minor. A more thorough analysis of floodplain depths and durations for existing vs. project conditions will be completed for final design.

14. Recommendations

Alternatives 1, 2A and 2B will provide the best solution for a restored stream. Also these alternatives will have significantly fewer maintenance requirements than Alternative 3 (fish ladder).

Creek Design Two provides the recommended restoration cross-sections, plan and slope requirements. Pools, riffles and bars will be allowed to form over time.

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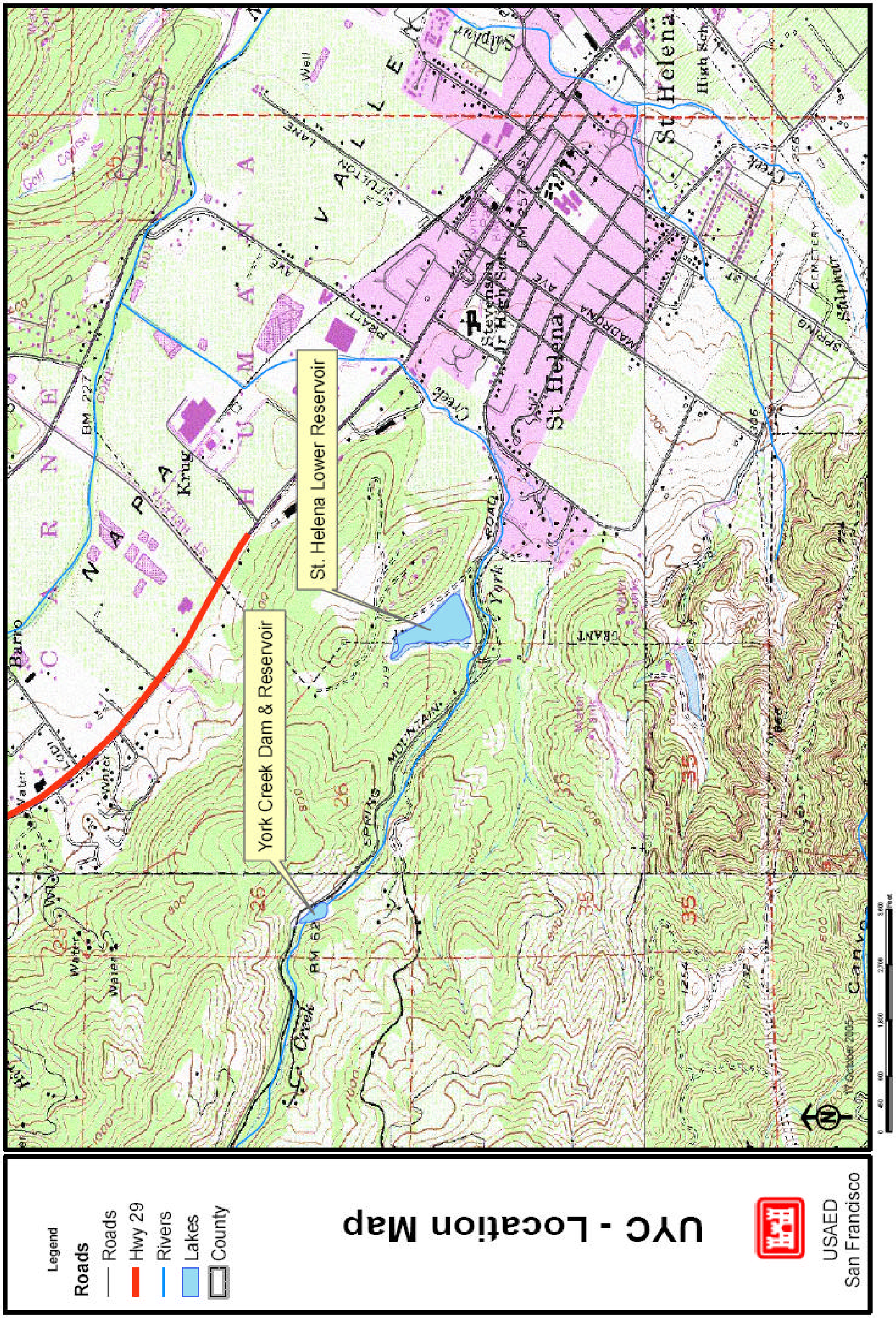

Plate 1. Location Map

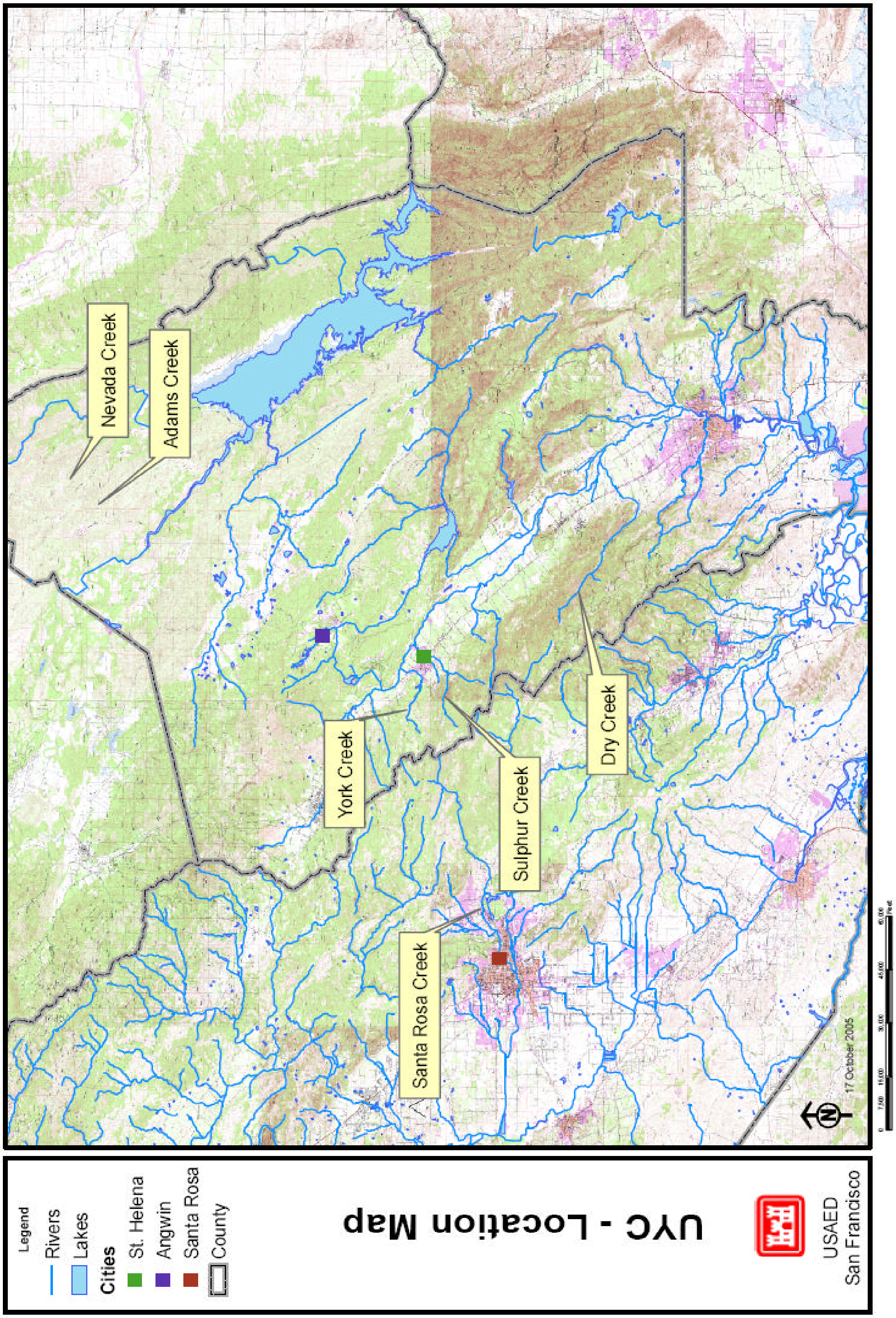

Plate 2. Location of nearby streams.